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Rundini

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(54) **CRANK SYSTEMS AND METHODS**

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B62M 1/02 (2006.01)

(52) **U.S. Cl.**

CPC **B62M 3/00** (2013.01)

(58) **Field of Classification Search**

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USPC 74/594.1–594.3; 280/259–261; 474/12;
482/57

IPC B62M 1/02, 3/00
See application file for complete search history.

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Primary Examiner — Thomas R. Hannon

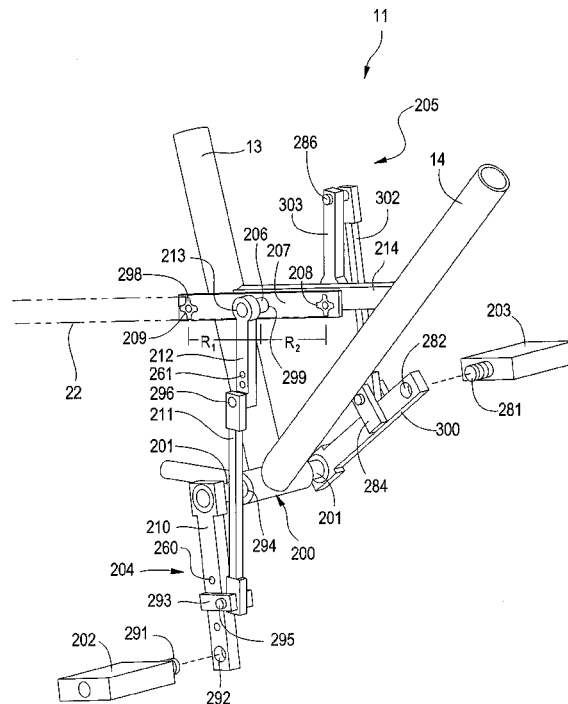
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(57) **ABSTRACT**

A crank system of the present disclosure has a rotating bar that is fixedly coupled to a first end of a first axle and for actuating a wheel, a first crank assembly coupled to the first end of the first axle and coupled to a first pedal, and a second crank assembly coupled to a second end of the first axle and a second pedal. The first crank assembly and the second crank assembly are coupled to the first axle such that the rotating bar is aligned with a wheel gear assembly adapted for rotating the wheel when the first pedal and second pedal are at their zenith and nadir positions, alternatively.

13 Claims, 15 Drawing Sheets



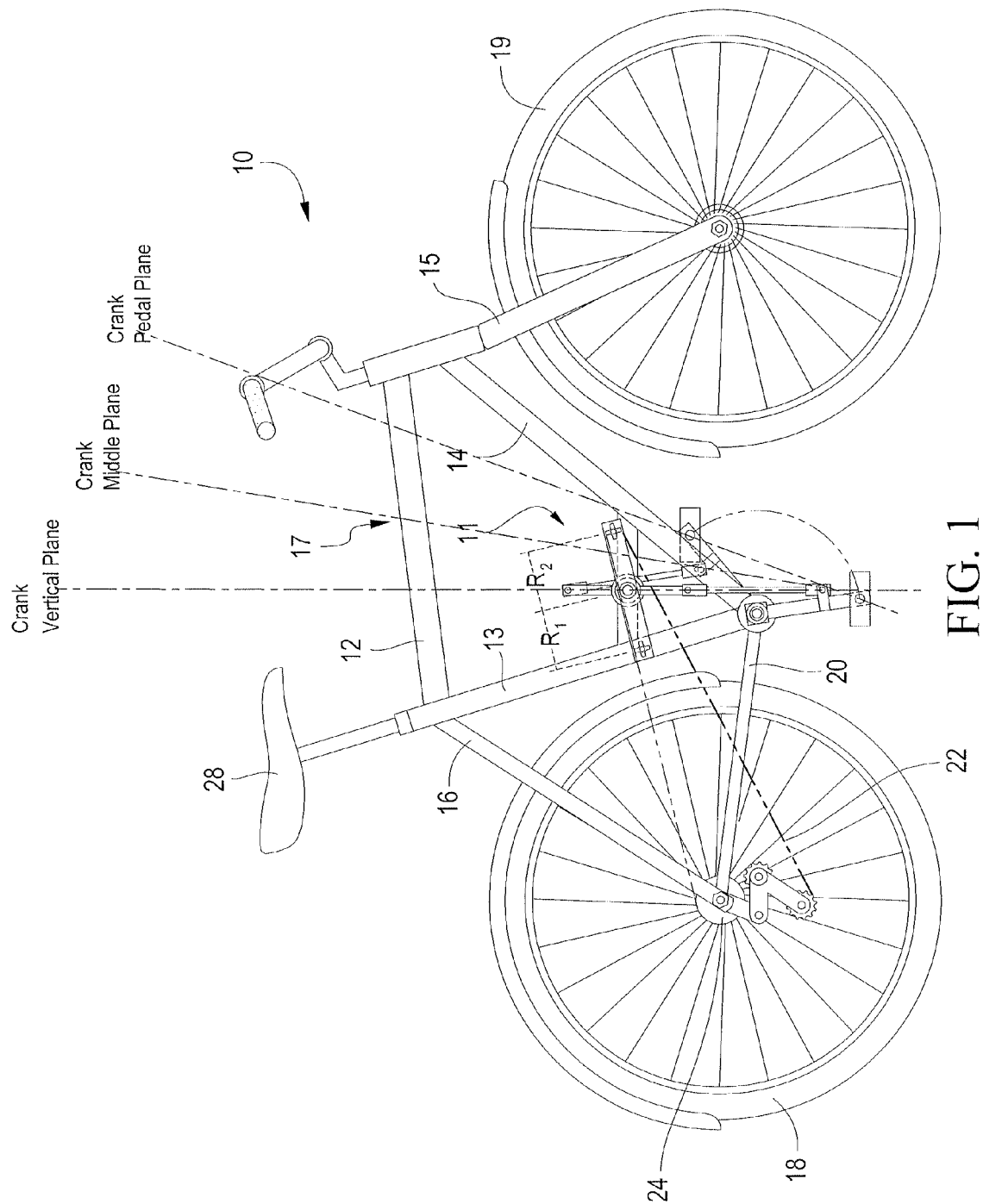


FIG. 1

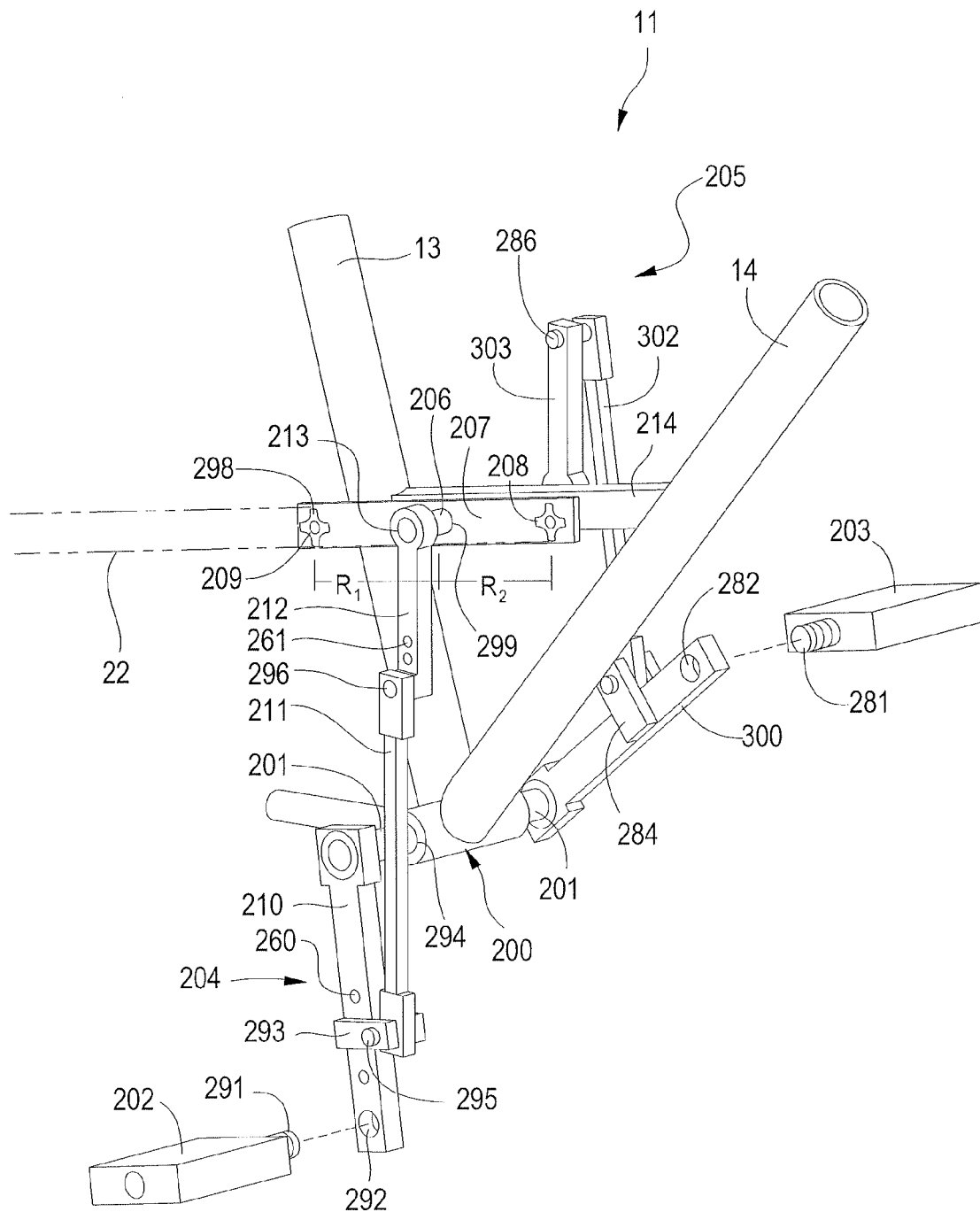


FIG. 2A

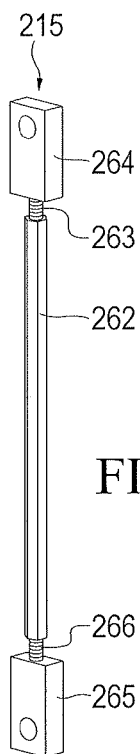


FIG. 2B

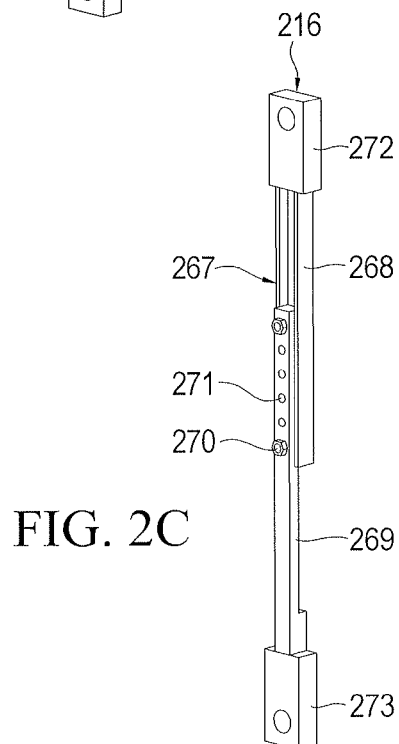


FIG. 2C

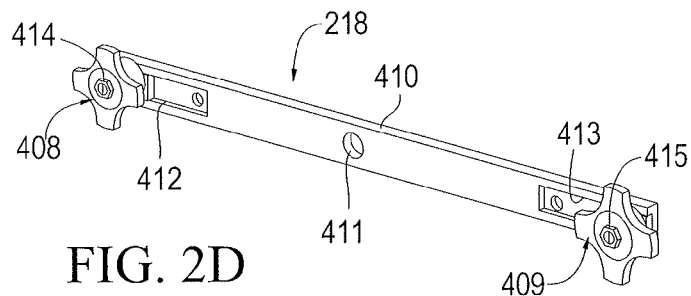


FIG. 2D

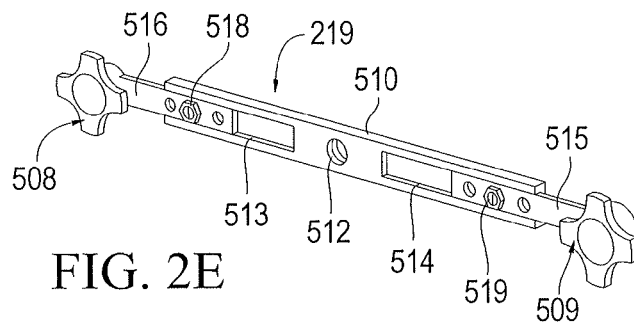


FIG. 2E

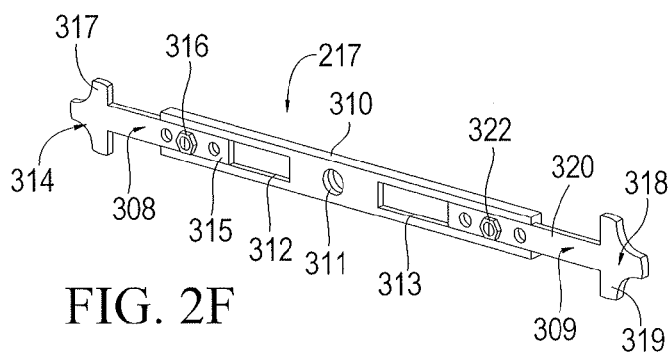


FIG. 2F

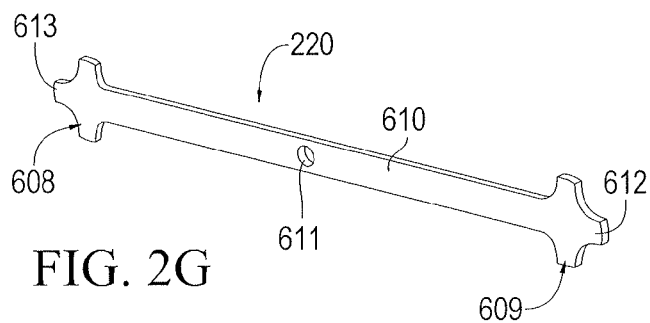


FIG. 2G

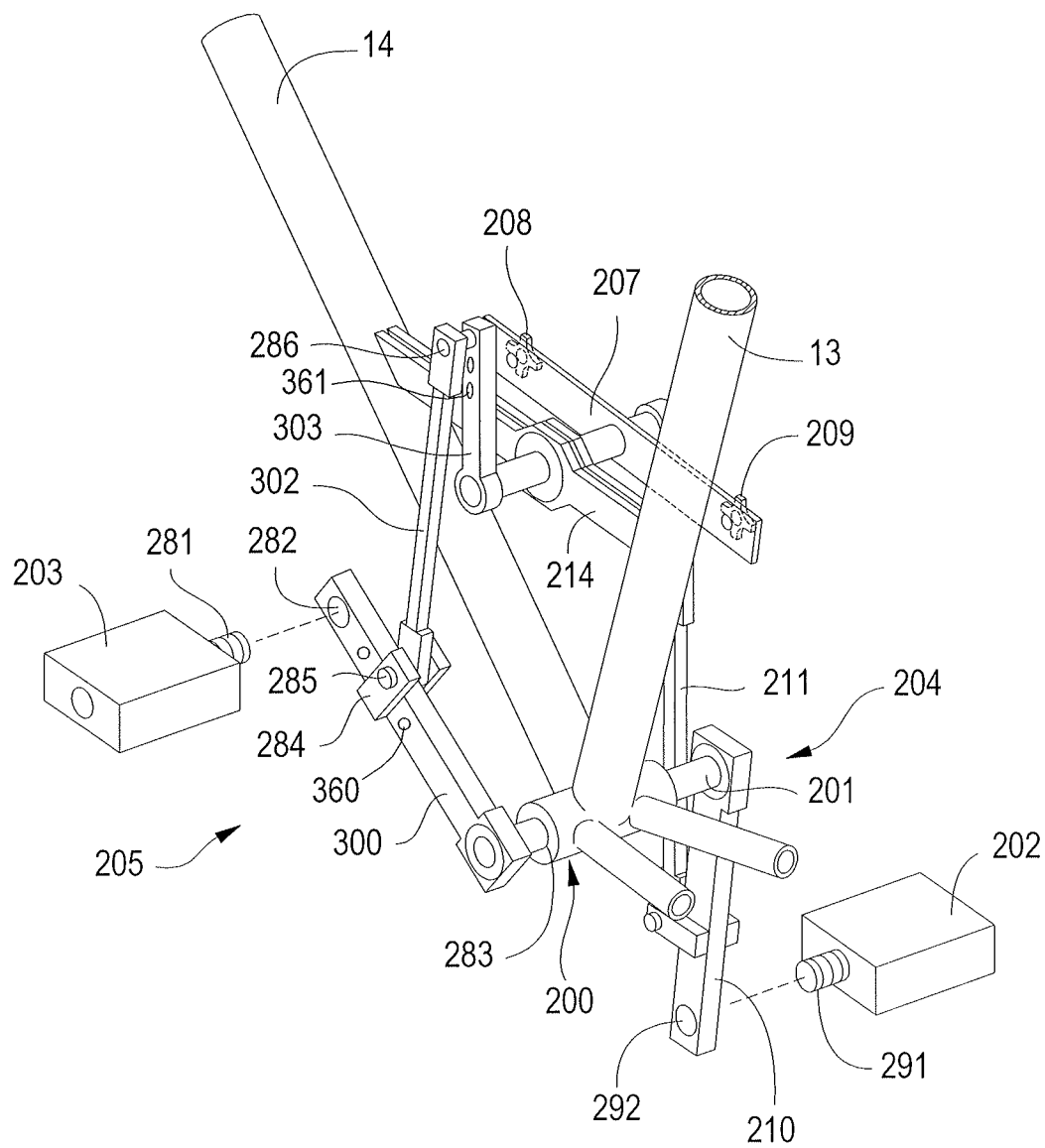


FIG. 3

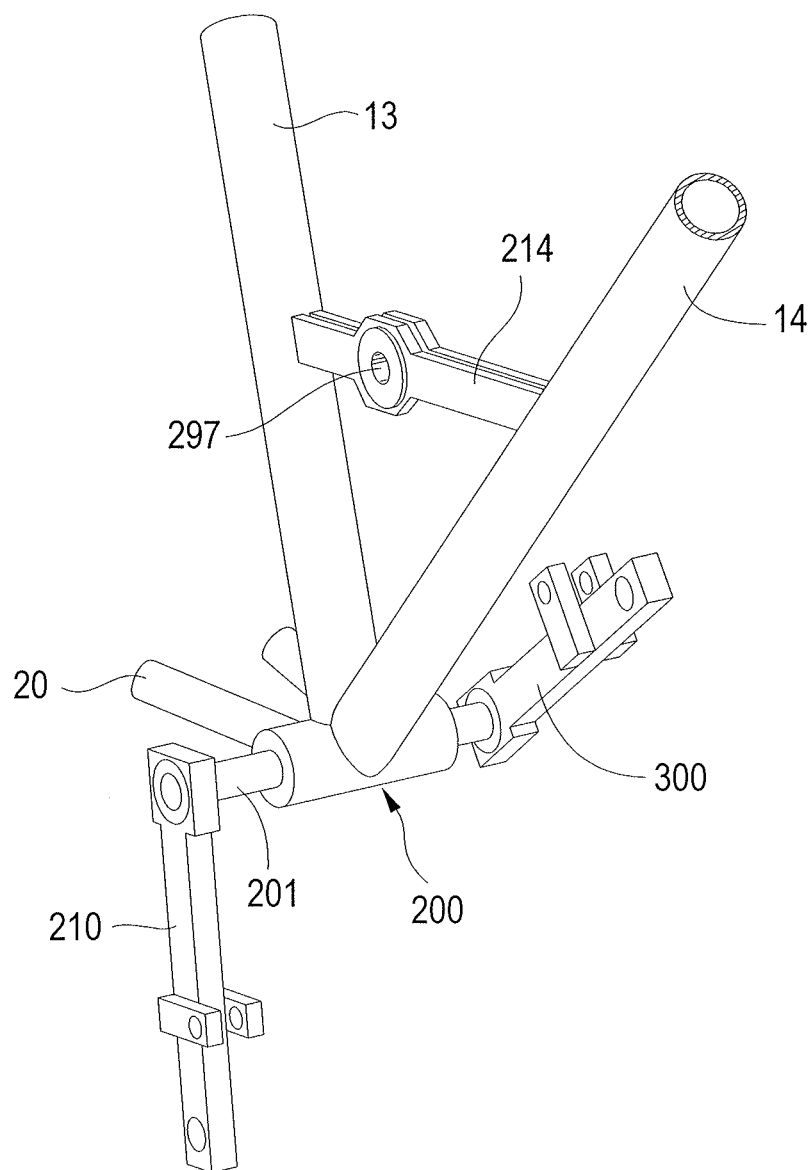


FIG. 4

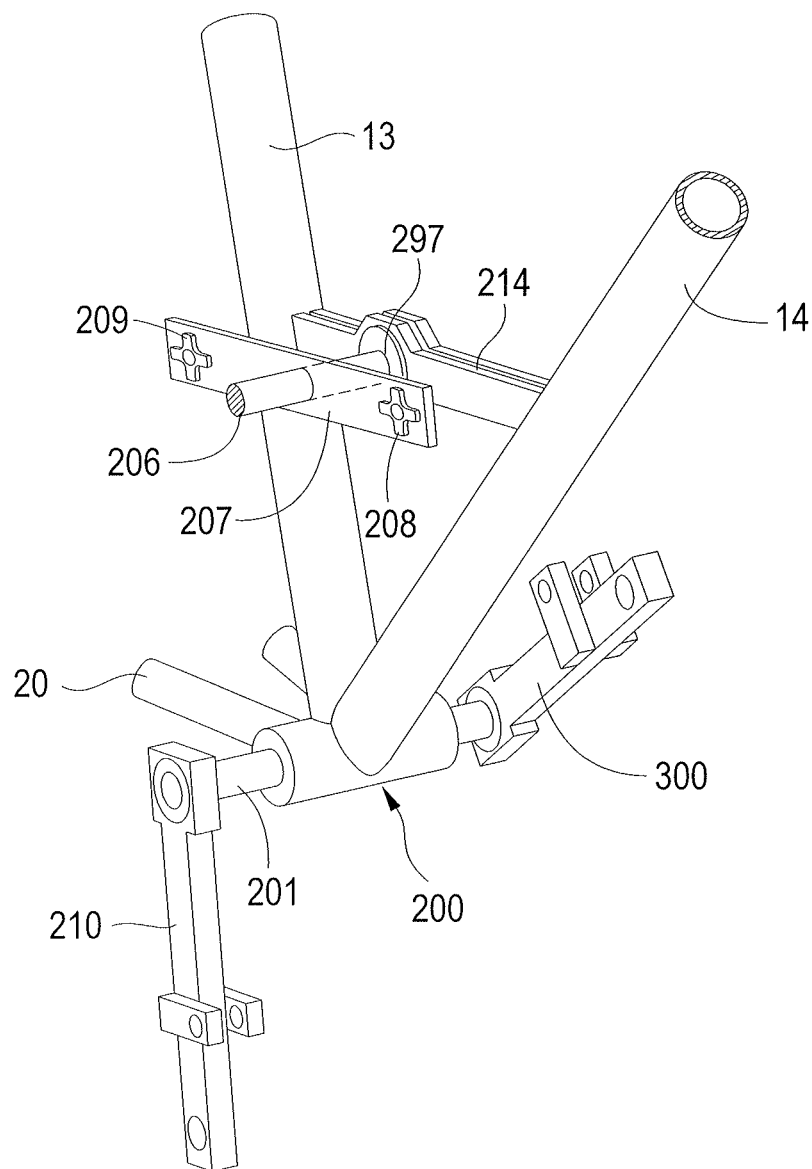


FIG. 5

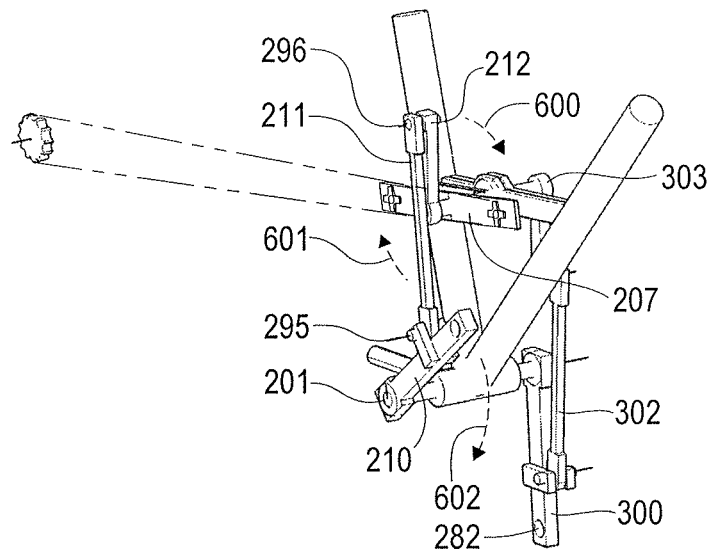


FIG. 6A

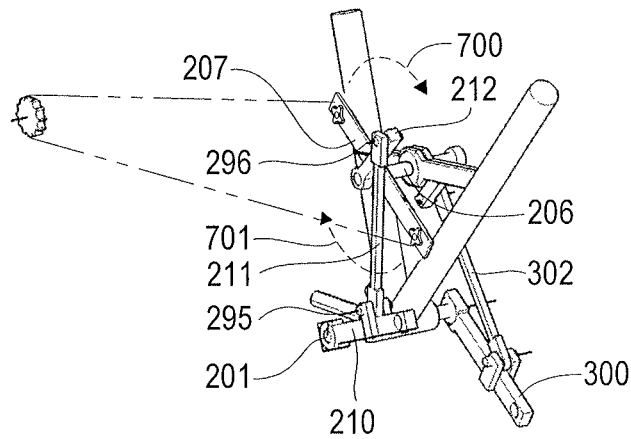


FIG. 6B

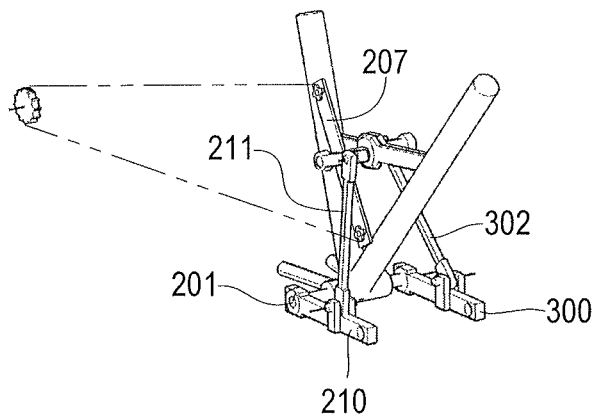


FIG. 6C

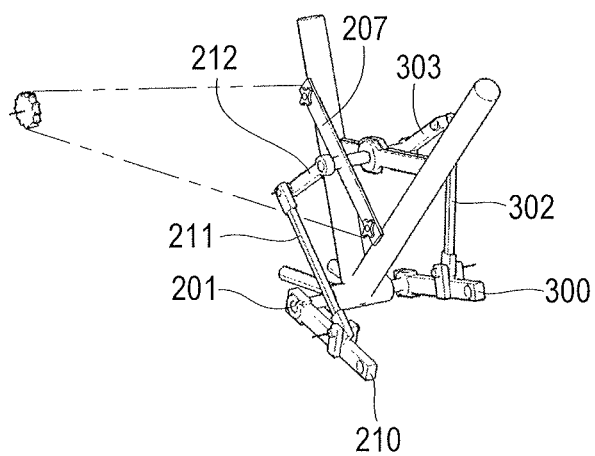


FIG. 6D

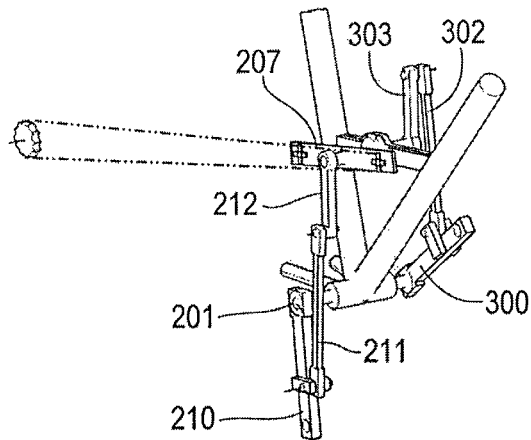


FIG. 6E

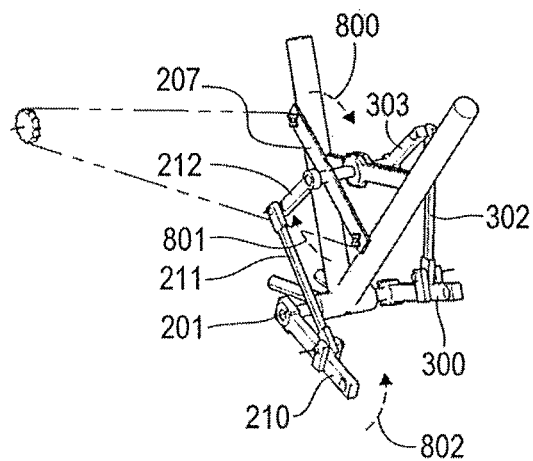


FIG. 6F

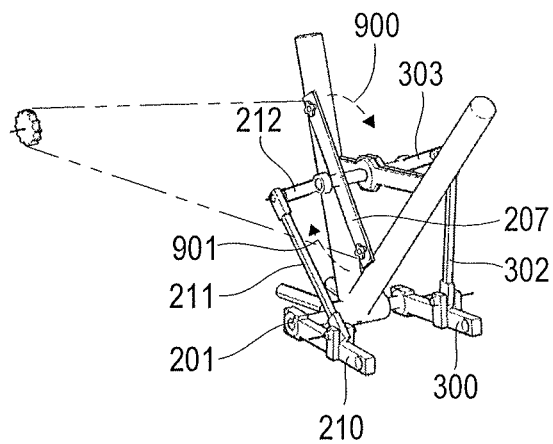


FIG. 6G

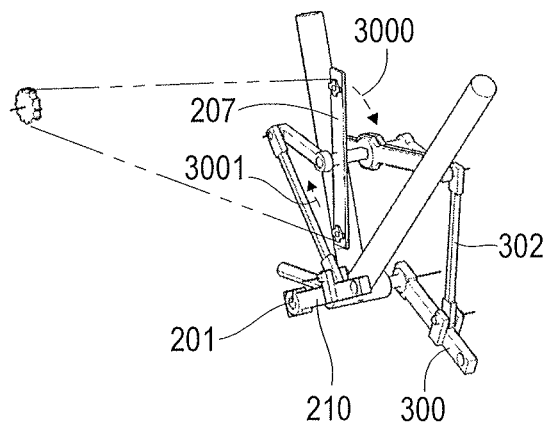


FIG. 6H

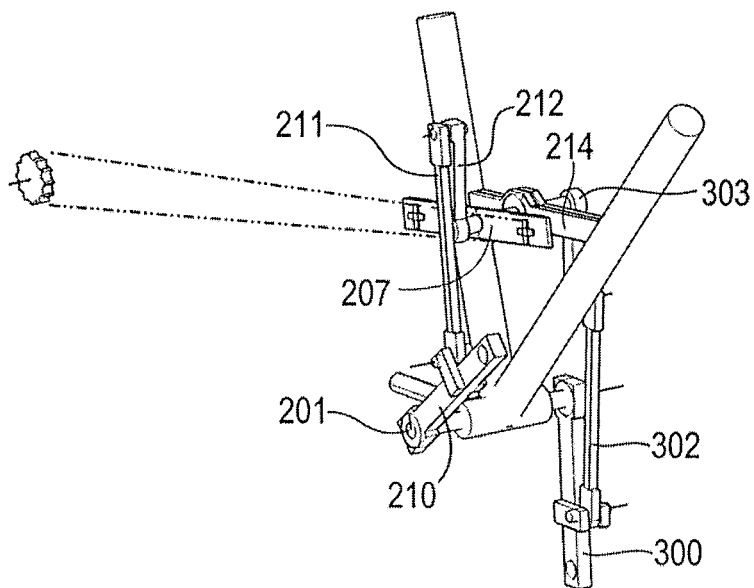


FIG. 6I

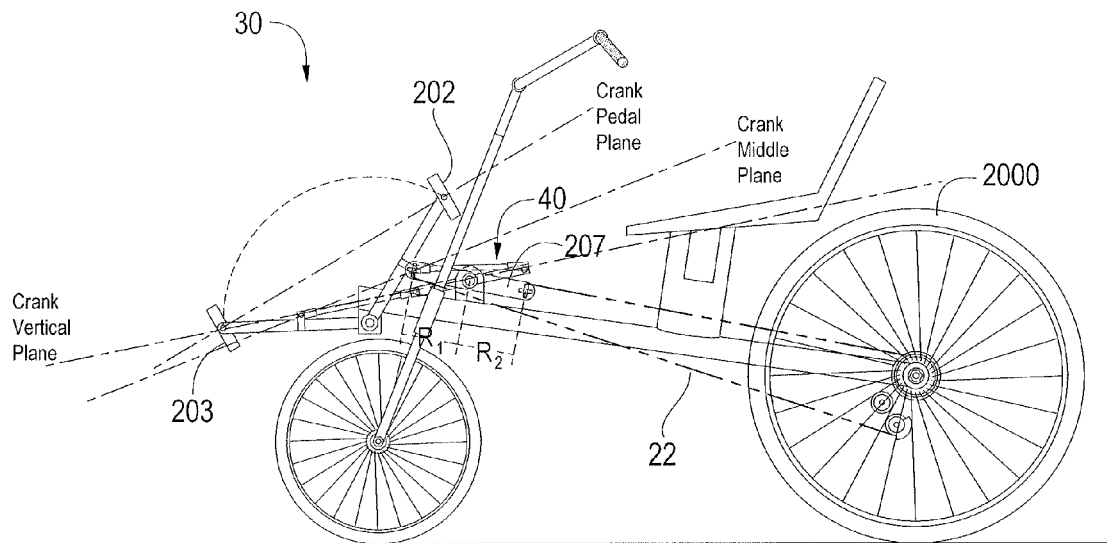


FIG. 7

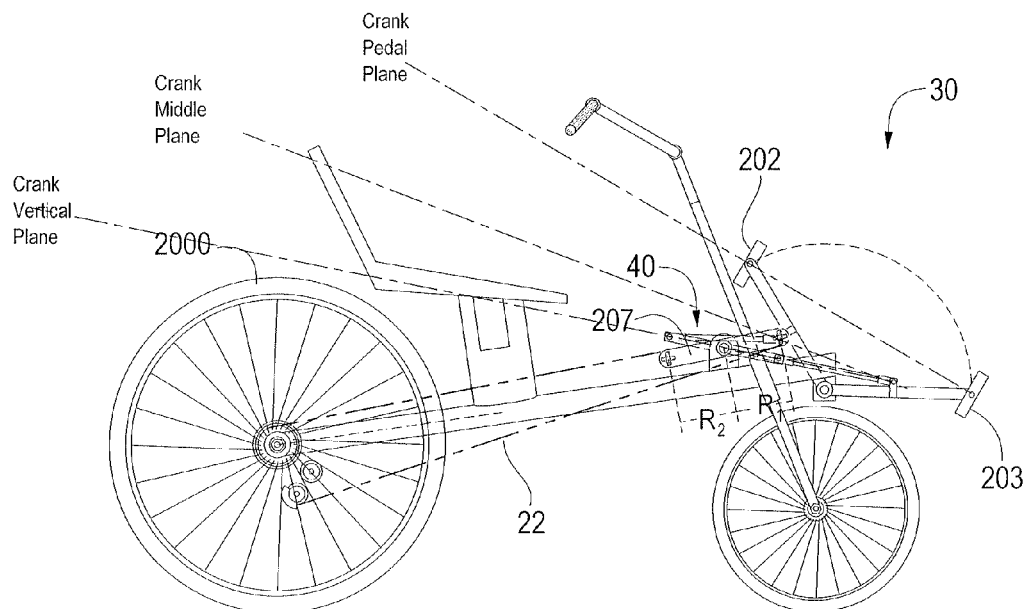


FIG. 8

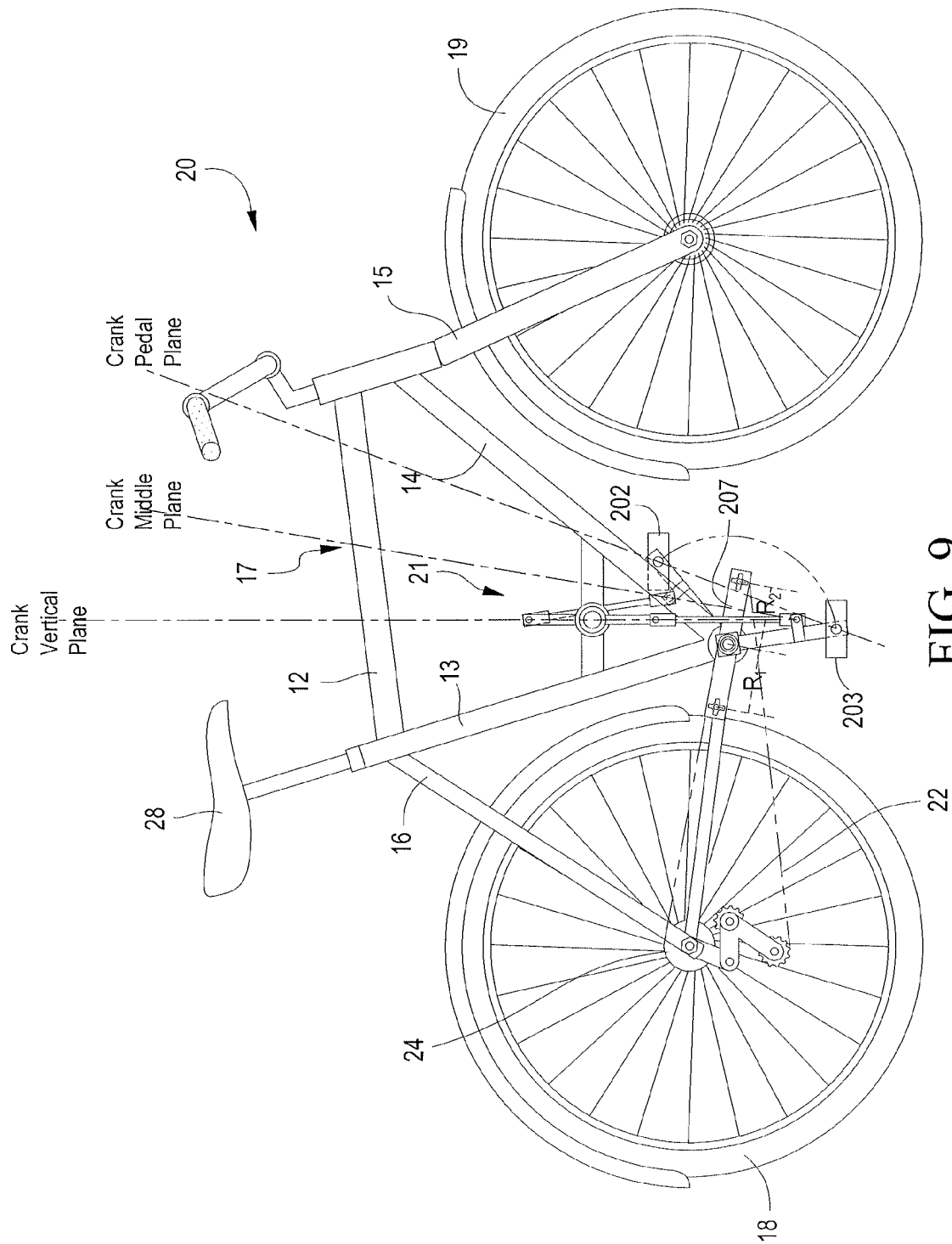


FIG. 9

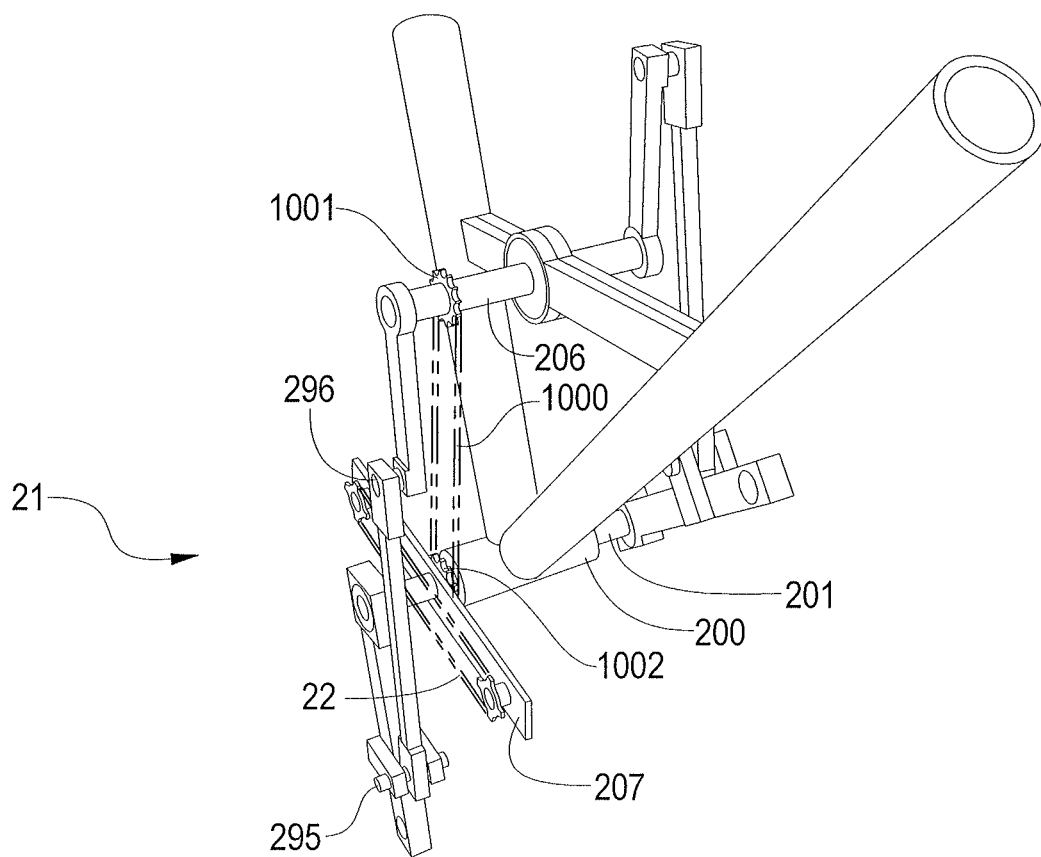


FIG. 10

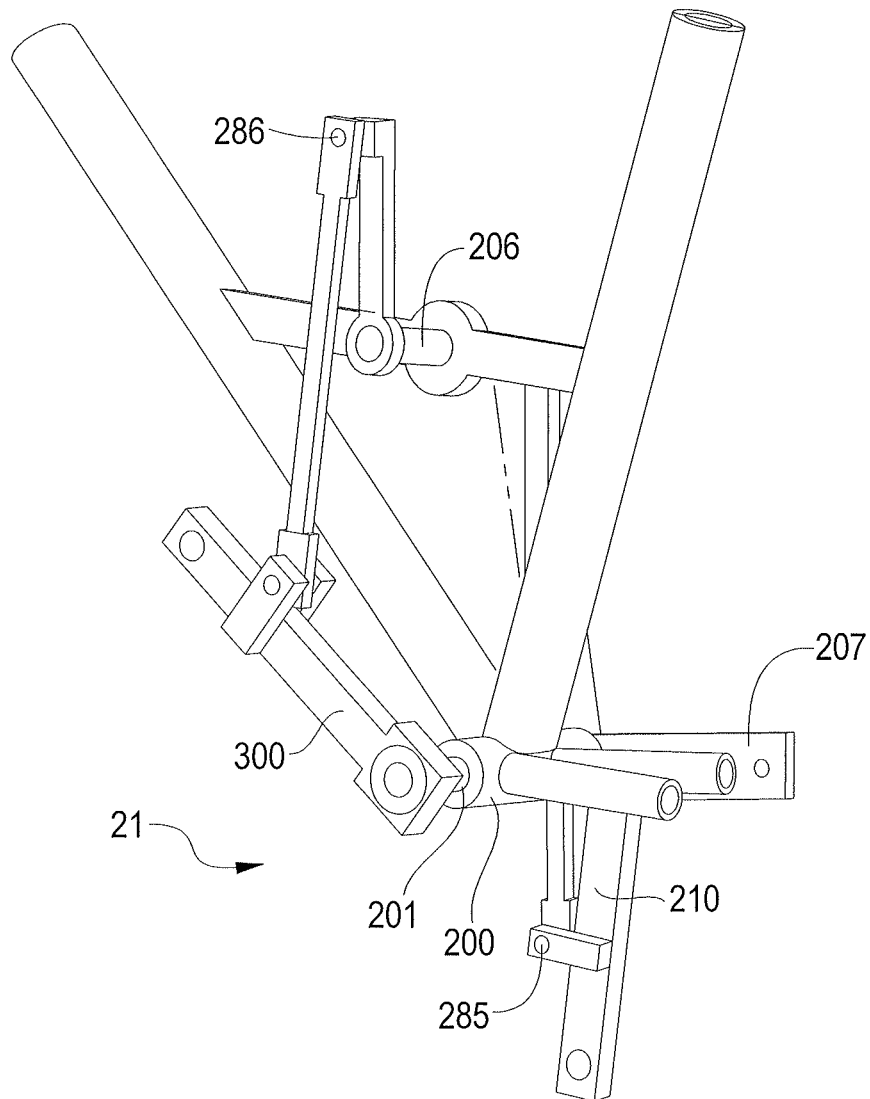


FIG. 11

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CRANK SYSTEMS AND METHODS

BACKGROUND

A drive train system of a bicycle is designed to translate a bicyclist's rotational pedaling motion and the power related thereto into linear motion. This translation enables a bicyclist to induce forward motion while riding the bicycle via rotation of the pedals with the bicyclist's feet.

The drive train typically comprises a set of pedals wherein each pedal is rotatably coupled to a crank arm, and each crank arm is fixedly coupled to a chain wheel. Conventionally, the chain wheel is round and a chain moveably interfaces with the teeth (or sprockets) of the wheel. Additionally, the chain moveably interfaces with gears coupled to a wheel. Thus, as the bicyclist rotates the pedals, the rotational movement induces rotation in the gears, which causes the wheel to rotate and the bicycle to move forward.

In a typical bicycle, as described hereinabove, a bicyclist rotates the pedals 360° in order to induce motion in the corresponding wheel. Due to the nature of the forces being cyclically applied to the pedals during rotation, the torque provided to the wheel is not uniform throughout the 360° cycle. In this regard, typically uniformity in the torque provided occurs in that portion of the rotation when the force applied is tangent to rotation.

SUMMARY

Generally, embodiments of the present disclosure provide a crank system that has a rotating bar that is fixedly coupled to a first end of a first axle and for actuating a wheel, a first crank assembly coupled to the first end of the first axle and coupled to a first pedal, and a second crank assembly coupled to a second end of the first axle and a second pedal. The first crank assembly and the second crank assembly are coupled to the first axle such that the rotating bar is aligned with a wheel gear assembly adapted for rotating the wheel when the first pedal and second pedal are at their zenith and nadir positions, alternatively.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure can be better understood with reference to the following drawings. The elements of the drawings are not necessarily to scale relative to each other, emphasis instead being placed upon clearly illustrating the principles of the disclosure. Furthermore, like reference numerals designate corresponding parts throughout the several views.

FIG. 1 depicts a side elevation view of a bicycle having a crank system in accordance with an embodiment of the present disclosure.

FIG. 2A depicts a chain-engaging side perspective view of the crank system such as is depicted in FIG. 1.

FIG. 2B depicts another exemplary mid crank arm of the crank system such as is depicted in FIG. 2A.

FIG. 2C depicts another exemplary mid crank arm of the crank system such as is depicted in FIG. 2A.

FIG. 2D depicts another exemplary rotating bar of the crank system such as is depicted in FIG. 2A.

FIG. 2E depicts another exemplary rotating bar of the crank system such as is depicted in FIG. 2A.

FIG. 2F depicts another exemplary rotating bar of the crank system such as is depicted in FIG. 2A.

FIG. 2G depicts another exemplary rotating bar of the crank system such as is depicted in FIG. 2A.

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FIG. 3 depicts a non-chain-engaging side perspective view of the crank system shown in FIG. 2.

FIG. 4 depicts a cut away view of the crank system depicted in FIG. 1 showing an exemplary mounting bar and pedal crank.

FIG. 5 depicts a cut away view of the crank system of FIG. 1 depicting an exemplary rotating bar coupled to the mounting bar depicted in FIG. 4.

FIGS. 6A-6I depicts an exemplary complete rotation of the rotating bar resulting from translation of up and down movement as applied to pedals such as is depicted in FIG. 1.

FIG. 7 depicts a non-chain-engaging side of another embodiment of the crank system such as is depicted in FIG. 1 implemented on a recumbent bicycle.

FIG. 8 depicts a chain-engaging side of the crank system such as is depicted in FIG. 7.

FIG. 9 depicts another embodiment of the crank system such as is depicted in FIG. 1 implemented at a bracket axle location of a bicycle.

FIG. 10 depicts a chain-engaging side of the crank system such as is depicted in FIG. 9.

FIG. 11 depicts a non-chain-engaging side view of the crank system such as is depicted in FIG. 9.

DETAILED DESCRIPTION

FIG. 1 depicts a bicycle 10 equipped with a crank system 11 in accordance with an embodiment of the present disclosure. As shall be discussed further herein, the crank system 11 while shown in FIG. 1 as operably coupled to the bicycle 10, the crank system 11 may also be operably coupled to any type of vehicle or any other device that is manually foot-powered. In this regard, the crank system 11 may be operably coupled to other types of vehicles that are fully or partially foot-powered or motor-powered vehicle. For example, the crank system 11 may be used on a recumbent, which is a vehicle in which the cyclist reclines (in a substantially horizontal position) when riding and operating the recumbent.

The bicycle 10 comprises an exemplary frame 17 coupled to a back wheel 18 and a front wheel 19. The bicycle frame 17 comprises a top tube 12, a head tube 15, a seat tube 13, a down tube 14, a seat stay 16, and a chain stay 20. Note that the terms "tube" and "stay" refer to structural members of the bicycle 10. A "stay" refers to a thin, usually straight structural member; whereas the term "tube" refers to any type of metal tubing. Each of the stays and/or tubes may be comprised of aluminum, steel, titanium, or any type of material known in the art or future-developed that can structurally withstand forces induced when such forces are applied to the frame for inducing forward motion in the bicycle 10.

The top tube 12 connects the head tube 15 to the seat tube 13. Notably, a seat 28 is coupled to a top of the seat tube 13. In one embodiment, the top tube 12 is welded at respective ends to the head tube 15 and the seat tube 13. The head tube 15 is coupled to the front wheel 19.

The down tube 14 connects the head tube 15 to a bottom bracket shell (not shown), which is a hollow receptacle portion of the frame for receiving a bottom bracket (not shown) that couples a crank system to the frame 17. In one embodiment, the hollow receptacle portion may be cylindrical and unitarily formed in the frame 17 for coupling the crank system 11 to the frame 17.

Additionally, the seat tube 13 extends from the seat 28 to the bottom bracket shell. Notably, as described further herein, the seat tube 13 is connected to the top tube 12 (described hereinabove) and the seat stay 16.

Further, the seat stay **16** and the chain stay **20** are each coupled to a fork end (not shown) that is coupled to an axle (not shown) coupling the wheel **18** to the frame **17**. The chain stay **20** further connects to the bottom bracket shell as well. In the exemplary bicycle **10**, the chain stay **20** runs parallel to a chain **22**. Note that a fork end comprises an opening to which the axle of the wheel **18** is coupled.

The bicycle **10** incorporates a traditional diamond frame. Note however that the crank system **11** may be used on other types of frames in other embodiments. For example, in some modern mountain bicycles, the top tube **12** slopes downward toward the seat tube **13**. The crank system **11** may also be used on such a bicycle configuration as well as any other frame configurations known in the art or future-developed.

As described hereinabove with reference to the exemplary frame **17**, the various components, i.e., the top tube **12**, the head tube **15**, the down tube **14**, the seat tube **13**, the seat stay **16**, and the chain stay **20** may be welded one component to the other to form the frame **17**. However, other methods, other than welding, may be used in other embodiments to form a unitary frame **17**.

The crank system **11** translates up and down pedaling motion (as opposed to rotating motion) effectuated by a bicyclist into rotating motion in the wheel **18**. The crank system **11** enables more uniform torque transferred to the wheel **18**, which is described further herein.

FIG. 2A depicts a chain-engaging side view of the crank system **11** in accordance with an embodiment of the present disclosure. The crank system **11** comprises a mounting bar **214** that is fixedly coupled to and between the down tube **14** and the seat tube **13**. Such mounting bar **214** may be fixedly coupled, for example, via welding. Further, the crank system **11** comprises crank assemblies **204** and **205**, which are described further herein. The crank assemblies **204** and **205** couple an axle **206** and a rotating bar **207** to pedals **202** and **203**. The rotating bar **207** is coupled to cogs **208** and **209**, wherein the cogs **208** and **209** are coupled to the rotating bar **207** on opposing ends of the rotating bar **207**.

Note that in another embodiment, the crank system **11** may be rotated clockwise or counterclockwise by the point indicated by an axle **201**, to be mounted at any angle with reference to the ground plane, i.e., the plane parallel to the ground relative to the bicycle **10** (FIG. 1).

In this regard, the rotating bar **207** may be rotated and fixedly coupled to the axle **206** such that the top of the cogs **208** and **207** align with the line tangent to the gear **24** (FIG. 1) when the pedal **202** or **203**, have reached the zenith or nadir position, which is described further herein.

In one embodiment, the mounting bar **214** may be fixedly coupled to the down tube **14** and the seat tube **13** such that the mounting bar **214** is parallel with the top tube **12**. However, the mount bar **214** may be fixedly coupled to the down tube **14** and the seat tube **13** such that it is at an angle relative to the top tube **12**, as indicated hereinabove. In one embodiment, the mounting bar **214** may be mounted to just one tube. For example, the mounting bar **214** may be mounted only to seat tube **13**, down tube **14**, or top tube **12**. Further, the mounting bar **214** may be mounted to any other part of the frame that allows operation as described.

In addition, the rotating bar **207** is rotatably coupled to the mounting bar **214** via an axle **206** that rotates within a bore (not shown) in the mounting bracket **214**. The rotating bar **207** is fixedly coupled to the axle **206** via a bore **299**. In this regard, the axle **206** extends through the bore **299**, and an inside surface of the bore **299** is fixedly coupled to the axle **206**. In one embodiment, the axle **206** is welded to the inside surface of the bore **299**; however, the axle **206** may be fixedly coupled

to the bore **299** via other methods in other embodiments. In one embodiment, the axle **206** may rotate in only one direction, i.e., clockwise from the perspective of the rotating bar **207** from the chain-engaging side of the crank system **11**, as shown on FIG. 2.

The cogs **208** and **209**, as identified hereinabove, comprise a series of teeth (or projections) **298** that interface with and induce movement in the chain **22** (FIG. 1). Note that in one embodiment, the cogs **208** and **209** have four (4) teeth as shown; however, fewer or additional teeth are possible in other embodiments. In another embodiment, in place of the cogs **208** and **209**, the teeth may be formed in the outside perimeter of the rotating bar **207** to interface with and induce movement in the chain **22**.

Further note that in one embodiment, the chain **22** is a roller chain that enables smooth engagement with the teeth of the cogs **208** and **209**. However, other types of chains may be used in other embodiments of the present disclosure.

In addition, in one embodiment, the chain **22** may be replaced with a belt. The belt may be adapted for engagement with a gear/pinion system.

Note that the chain **22** is a motion transferring device. In this regard, the chain engages the rotating bar **207** and transfers the rotating motion to the gear assembly **24** and the wheel **18**. Further, if a belt is employed in the above-described embodiment, it is also a motion transferring device.

Further note that FIG. 2A further shows radii R_1 and R_2 illustrated of the rotating bar **207**. The length of the radii R_1 and R_2 defines the rotational diameter of the chain **22**. Further, more than one rotating bar **207**, having greater or lesser radii, may be fixedly coupled along to the axle **206**. Further, the position of each cog **208** and **209** along the rotating bar **207** or the rotating bar itself may be adjustable, therefore changing the radii R_1 and R_2 , as described further herein with reference to FIGS. 2D through 2G.

Additionally, the crank system **11** comprises a set of pedals **202** and **203**. For purposes of this discussion, the pedal **202** is the pedal on the chain-engaging side of the crank system **11**. Note that the chain-engaging rotating bar **207** may be implemented on either side of the crank system **11**, and the non-chain-engaging side is described with reference to FIG. 3.

Note that the pedals crank arms **210** and **300** may be any length of pedal crank arm known in the art or future-developed. For example, the pedals crank arms **210** and **300** may be seventeen (17) centimeter or twenty-five (25) centimeter pedal crank arms.

Each pedal **202** and **203** is rotatably coupled to respective crank assemblies **204** and **205**. In one embodiment, the crank assemblies **204** and **205** are substantially similar.

The crank assembly **204** comprises three crank arms, including a pedal crank arm **210**, a mid crank arm **211**, and a crank arm **212**. The pedal crank arm **210** is rotatably coupled to the pedal **202** via an axle **291** and corresponding bore **292** on one end. On an opposing end of the pedal crank arm **210**, the pedal crank arm **210** can be fixedly coupled or can be rotatably coupled to a bracket axle **201** that rotates within a bore **294** (FIG. 2A) and **283** (FIG. 3) in a bottom bracket shell **200**. Note that the bracket axle **201** travels through the bore **294** through the width of the bottom bracket shell **200** protruding on the non-chain-engaging side of the bottom bracket shell **200** through the bore **283** for receiving the a pedal crank arm **300** of the crank assembly **205** on the non-chain-engaging side of the crank system **11**, which is described further herein with reference to FIG. 3.

In one embodiment, the bottom bracket shell **200** and/or the bracket axle **201** and/or bore **294** and **283** can be mounted

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to any part of the frame of the bicycle. In one embodiment the axle **201** can be fixedly coupled to the bottom bracket **200** or to the frame.

A fixed distance from the end of the pedal crank arm **210** is a mounting bracket **293** coupled to the pedal crank arm **210**. The mounting bracket **293** freely retains the mid crank arm **211** via a pin assembly **295** such that rotational movement is allowed on and about the pin assembly **295**. Furthermore, the position of the mounting bracket **293** along the pedal crank arm **210** may be adjustable. In another embodiment, the mid crank arm **211** may be coupled directly to the pedal crank **210** via the pin **295** and mounted at a fixed or adjustable position along the pedal crank arm **210**.

Further, the lengths of the crank arms **210**, **211**, and **212** may be adjustable. In this regard, the crank arm **212** comprises fastener openings **261** through which the pin **296** may be inserted for coupling the mid crank arm **211** thereto. The additional openings **261** allow the crank arm **212** to be adjustable. Additionally, the crank arm **210** comprises fastener openings **260** through which the pin **295** may be inserted for coupling the pedal crank arm **210** thereto. The additional openings **260** allow the crank arm **210** to be adjustable.

On an end opposite the pin assembly **295**, the mid crank arm **211** is rotatably coupled to the crank arm **212** via a pin assembly **296**. Notably, the mid crank arm **211** rotates relative to the crank arm **212** on or about the pin assembly **296**.

The crank arms **212** and **303** are fixedly coupled to the axle **206**, positioned at the opposite end of the axle **206** and longitudinally opposed relative to one another throughout the rotational cycle. In this regard, the rotational position shown in FIG. 2A wherein the pedal **202** is at its nadir and the pedal **303** is at its zenith, the end of the crank arm **212** that is coupled to the mid crank arm **211** is positioned below the axle **206**; whereas, the end of the crank arm **303** that is coupled to the mid crank arm **302** is positioned above the axle **206**. In this regard the terms “above” and “below” the axle **206** are referred along the “crank vertical plane” described further herein.

The term “rotational cycle” as used hereinabove refers to one complete 360° rotation of the rotating bar **207** and axle **206**. In this regard, at 180° through the rotational cycle, the pedal **202** as shown in FIG. 2A would be positioned at its zenith and the pedal **203** would be positioned at its nadir.

The “crank vertical plane” as shown in FIG. 1, 7, 8, 9, is a reference surface passing through the crank arms **212**, **303** and axle the **206**, when one of the pedal **202** or **203** is at its nadir or zenith position.

The “crank pedal plane” as shown in FIG. 1, 7, 8, 9 is a reference surface passing through the center axles of the pin assemblies **291** and **281**, when one of the pedal **202** or **203** is at its nadir or zenith position. In this regard, the terms nadir and zenith, for the pedals **202** and **203**, are referred along to the “crank pedal plane”.

The “crank middle plane”, as shown in FIG. 1, 7, 8, 9, is a reference surface passing through the center axles of the pin assemblies **295** and **285** in the mounting brackets **293** and **284**, when one of the pedal **202** or **203** is at its nadir or zenith position. In another embodiment the “crank middle plane” is a reference surface passing through the center axles of the pin **295** and **285** when the mid crank arms **211** or **302** are coupled directly to the pedal crank arms **210** and **300** and when one of the pedal **202** or **203** is at its nadir or zenith position.

The crank system **11**, the crank system **21** and crank system **40**, which are described further herein, may be mounted at any angle formed by the “crank vertical plane” and “crank middle plane”. Furthermore, the crank system **11**, the crank

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system **21** and crank system **40**, may be mounted at any angle formed by the “crank middle plane” and “crank pedal plane.”

FIGS. 2B and 2C depict exemplary mid crank arms **215** and **216** in accordance with an embodiment of the present disclosure that allow for adjusting the length of the mid crank arms **215** and **216**. Two substantially identical mid crank arms **215** and **216** may replace the mid crank arms **211** and **302** depicted in FIG. 2A so that the mid crank arms are adjustable.

In this regard, the mid crank arm **215** may be attached via a coupler **264** to the pin **296** (FIG. 2A) and may be attached via a coupler **265** to the pin **295** (FIG. 2A). The mid crank arm **215** further comprises a shaft **262** that is threadedly coupled via a threaded portion **263** to the coupler **264** and threadedly coupled via a threaded portion **266** to the coupler **265**. In such an embodiment, the length of the mid crank arm **215** may be adjusted by rotating the shaft **262** relative to the couplers **266** and **265**.

Further, the mid crank arm **216** may be attached via a coupler **272** to the pin **296** (FIG. 2A) and may be attached via a coupler **273** to the pin **295** (FIG. 2A). The mid crank arm **216** further comprises a shaft **267**. The shaft **267** comprises two sections, including section **268** and **269** that are slidably coupled one to the other. In this regard, fasteners **270**, e.g., bolts or screws, may be loosened and/or removed from openings **271**. When the fasteners **270** are removed or loosened, each section **268** and **269** may be slidably adjusted relative to the other, e.g., the sections may be pulled apart or pushed together thereby modifying the length of the crank arm **216**.

FIGS. 2D through 2G depict rotating bars **217-220** in accordance with an embodiment of the present disclosure that allow for adjusting the radii R1 and R2 depicted in FIG. 2A.

FIG. 2D depicts the bar **218** comprising cogs **408** and **409** slidably attached to opposing ends of a bar member **410**. The bar member **410** comprises a bore **411** through which the rotating bar **218** is coupled to the axle **206** (FIG. 2A). The bar member **410** comprises two channels **412** and **413** to which the cogs **408** and **409** are slidably coupled. Notably, the cogs **408** and **409** may comprise fasteners **414** and **415** that may be removed or loosened so that the cogs **408** and **409** may be moved in a direction away from the bore **411**, thereby increasing the radii R1 and R2 shown in FIG. 2A, or toward the bore **411**, thereby decreasing the radii R1 and R2.

FIG. 2E depicts the rotating bar **219** comprising cogs **508** and **509** that are coupled to or integrally formed with slide guides **516** and **515**, respectively. The slide guides **515** and **516** are slidably attached to opposing ends of a bar member **510**. The bar member **510** comprises a bore **512** through which the rotating bar **219** is coupled to the axle **206** (FIG. 2A). The bar member **510** comprises two channels **513** and **514** to which the slide guides **516** and **515** are slidably coupled. Notably, the slide guides **515** and **516** may comprise fasteners **518** and **519** that may be removed or loosened so that the slide guides **515** and **516** may be moved in a direction away from the bore **512**, thereby increasing the radii R1 and R2 shown in FIG. 2A, or toward the bore **512**, thereby decreasing the radii R1 and R2.

FIG. 2F depicts the rotating bar **217**, which is similar to the rotating bar **219**; however, the rotating bar **217** comprises sliding members **308** and **309**. The sliding members **308** and **309** comprise toothed ends **314** and **318** integrally formed with slide guides **315** and **320**. The toothed ends **314** and **318** comprise teeth **317** and **319** that engage the chain **22** (FIG. 1). The sliding members **308** and **309** are slidably attached to opposing ends of a bar member **310**. The bar member **310** comprises a bore **311** through which the rotating bar **217** is coupled to the axle **206** (FIG. 2A). The bar member **310** comprises two channels **312** and **313** to which the sliding

members **308** and **309** are slidably coupled. Notably, the sliding members **308** and **309** may comprise fasteners **316** and **322** that may be removed or loosened so that the sliding members **308** and **309** may be moved in a direction away from the bore **311**, thereby increasing the radii **R1** and **R2** shown in FIG. 2A, or toward the bore **311**, thereby decreasing the radii **R1** and **R2**.

FIG. 2G depicts the bar **220**. Bar **220** comprises a bore **611** through which the rotating bar **220** may be coupled to the axle **206** (FIG. 2A). The bar **220** comprises a bar section **610** integrally formed with toothed ends **608** and **609**. The toothed ends **608** and **609** comprise teeth **613** and **612**, respectively, which engage the chain **22** (FIG. 1). In this regard, the bar section **610** and the toothed ends **608** and **609** are an integrally formed unitary rotating bar.

FIG. 3 depicts a non-chain-engaging side view of the crank system **11** in accordance with an embodiment of the present disclosure. Notably, in FIG. 3, the fixed mount bar **214** is shown fixedly coupled to and between the down tube **14** and the seat tube **13**, as described hereinabove. In addition, the rotating bar **207** is visible as well.

As indicated hereinabove and is shown in FIG. 3, the crank system **11** comprises the pedals **202** and **203**. The pedal **203** is the pedal on the non-chain-engaging side of the crank system **11**, which is the side view shown in FIG. 3.

The pedal **203** is rotatably coupled to its corresponding crank assembly **205** substantially in the same manner that pedal **202** is coupled to its corresponding crank assembly **204**. The crank assembly **205** comprises three crank arms, including a pedal crank arm **300**, a mid crank arm **302**, and a rotating bar crank arm **303**. The pedal crank arm **300** is rotatably coupled to the pedal **203** via an axle **281** and corresponding bore **282** on one end. On an opposing end of the pedal crank arm **300**, the pedal crank arm **300** can be fixedly coupled or can be rotatably coupled to the bracket axle **201** that rotates within the bore **294** (FIG. 2A) and **283** (FIG. 3) in the bottom bracket shell **200**. As noted hereinabove, the bracket axle **201** travels through the bore **294** and through the width of the bottom bracket shell **200** protruding on the chain-engaging side of the bottom bracket shell **200** through the bore **283** for receiving the pedal crank arms **210** and **300** of the crank assemblies **204** and **205**, respectively. Similar to the crank assembly **204** depicted in FIG. 2A,

A fixed distance from the pedal end of the pedal crank arm **300** is a mounting bracket **284** coupled to the pedal crank arm **300**. The mounting bracket **284** freely retains the mid crank arm **302** on a first end via a pin assembly **285** such that rotational movement is allowed about the pin assembly **285**. Furthermore, the position of the mounting bracket **284** along the pedal crank arm **300** may be adjustable. In another embodiment, the mid crank arm **302** may be coupled directly to the pedal crank **300** via the pin **285** and mounted at a fixed or adjustable position along the pedal crank arm **300**.

In addition, the lengths of the crank arms **300**, **302**, and **303** may be adjustable. In this regard, the crank arm **303** comprises fastener openings **361** through which the pin **286** may be inserted for coupling the mid crank arm **302** thereto. The additional openings **361** allow the crank arm **303** to be adjustable. Additionally, the crank arm **300** comprises fastener openings **360** through which the pin **285** may be inserted for coupling the pedal crank arm **300** thereto. The additional openings **360** allow the crank arm **300** to be adjustable.

On an opposing end the pin assembly **285**, the mid crank arm **302** is rotatably coupled to the crank arm **303** via a pin assembly **286**. Notably, the mid crank arm **302** rotates relative to the crank arm **303** on or about the pin assembly **286**.

FIGS. 1, 2 and 3 depict a position of the crank system **11** wherein the pedal **202** of the chain-engaging side is at its nadir (i.e., at its lowest point in a cycle wherein a cycle consists of moving the pedals from nadir to zenith and back to nadir). Further, the pedal **203** on the non-chain-engaging side is at its zenith (i.e., at its highest point in a cycle). As shown in FIG. 1, when one pedal is at its zenith and the other is at its nadir, the rotating bar **207** is aligned with the top of the gear system **24**.

With further reference to FIGS. 2 and 3, in one embodiment, a bicyclist may apply an upward and downward force to the pedals **202** and **203** that may be substantially perpendicular to the ground. Note that in another embodiment, the bicyclist may apply a force to the pedals **202** and **203** that is tangential to rotation of the pedals **202** and **203**.

In this regard, the movement with respect to the pedals **202** and **203** is an up and down movement. Movement of the crank assemblies **204** and **205** that induces chain rotation and wheel rotation is described further with reference to FIGS. 6A-6I.

Note that there exists a variety of pedaling techniques that may be applied by the bicyclist in use of the crank assembly **11**. The above technique described is for exemplary purposes only.

FIG. 4 depicts a cut away view of the crank system **11**. In this regard, FIG. 4 depicts the mount bar **214** coupled to the down tube **14** and the seat tube **13**. In addition, FIG. 4 depicts pedal crank arms **210** and **300** to which the pedals **202** (FIG. 2A) and **203** (FIG. 2A) are coupled, respectively.

FIG. 5 depicts another cut away view of the crank system **11** that further depicts the rotating bar **207**. As described hereinabove, the rotating bar **207** is fixedly coupled to the axle **206**, and the axle **206** is rotatably coupled to the bore **297** in the mounting bar **214**. Thus, the rotating bar **207** rotates 360° as the pedals **202** and **203** are pedaled up and down via a force that may be perpendicular to the ground.

A complete cycle consists one pedal beginning at its nadir and the other at its zenith, each pedal being actuated so that it returns back to its nadir and zenith, respectively. Such a cycle results in a complete 360° rotation of the axle **206** and rotating bar **207**.

Notably, when the rotating bar **207** rotates 360° in response to the forces applied to the pedals **202** and **203** through a cycle, the chain **22** (FIG. 1) engaging the cogs **208** and **209** moves as well, which induces movement of the wheel **18** (FIG. 1).

FIGS. 6A-6I depict operation of the crank system **11** illustrating in sequential order movement of the pedal crank arms and, in response, rotation of the axle **206** and rotating bar **207**. In particular, FIGS. 6A-6I depict a 360° rotation of the axle **206** and rotating bar **207** induced by a bicyclist's actuation of the pedals **202** (FIG. 2A) and **203** (FIG. 2A), i.e., downward actuation of pedal **202** and upward actuation of pedal **203**, in that order, through a complete cycle as described hereinabove.

In this regard, FIG. 6A depicts an initial position of the rotating bar **207** showing the cogs **208** and **209**, which are in-line with the top of gear system **24** of the back wheel **18** and the pedal **202** is at its zenith and the pedal **203** is at its nadir. As is shown in FIG. 2A, the chain **22** (FIG. 2A) moveably couples to the cogs **208** and **209** such that when the rotating bar **207** rotates, rotation is caused in the chain **22**. Note that the pedals **202** and **203** are not depicted in FIGS. 6A-6I for simplicity; however, pedal **202** is rotatably coupled to the pedal crank arm **210** via the bore **292**, and pedal **203** is rotatably coupled to the pedal crank arm **300** via bore **282**. In addition, in the initial position shown, mid crank arm **211** is

positioned such that a portion of the mid crank arm **211** is rotated above the rotating bar **207** and the crank arm **212** is rotated above the rotating bar.

Furthermore, on the non-chain-engaging side of the crank system **11** (a side view of which is shown in FIG. 3), the corresponding like components are positioned in an extended position. In this regard, the pedal crank arm **300** is extended and the pedal **203** has been actuated to its nadir. Thus, the mid crank arm **302** and the crank arm **303** are extended downward below the rotating bar **207**.

As operation proceeds, i.e., the pedal **202** is forced downward thereby actuating the pedal crank arm **210** in a direction indicated by reference arrow **602**, the axle **206** and rotating bar **207** rotates in a direction indicated by reference arrows **700**, **701**, **600** and **601**. Rotation of the axle **206** results from a downward, axial force on the crank arm **212** about the point located by the pin assembly **296**.

In response to force applied to pedal **202**, pedal **203** and the corresponding arms **300**, **302**, and **303** begin to rotate and in an opposite fashion. In this regard, as the pedal **202** is actuated downward, the pedal **203** begins to be pulled upward by rotation of the axle **206**.

With reference to FIGS. 6A and 6B, as the downward force is exerted on the pedal crank arm **210**, the pedal crank arm **210** rotates about the point located by the axle **201** as indicated by reference arrow **600** and **700**. The downward force is transferred to the mid crank arm **211**. The mid crank arm **211** rotates about the point located by the pin assembly **295**. The downward force is transferred to the rotating bar crank arm **212** by the pin assembly **296** causing the axle **206** and the rotating bar **207** to rotate as indicated by reference arrows **601**, **600** and **700**, **701**.

FIGS. 6C and 6D showed continued rotation of the axle **206** and the rotating bar **207** and downward movement of the pedal crank arm **210** until FIG. 6E. In FIG. 6E, the pedal crank arm **210** has been rotated to its full extent. In this regard, the pedal **202** to which the pedal crank arm **210** is rotatably coupled cannot be actuated downward any farther, and the pedal is at its nadir. Furthermore, the pedal **203** to which the pedal crank bar **300** is rotatably coupled cannot be pulled further upward, and thus opposite motion is initiated by downward force by the bicyclist on the pedal **203**.

FIGS. 6F-6I show the 180° completion of a half-cycle of the rotating bar **207**. In this regard, with reference to FIG. 6F, as the pedal **203** is forced downward and the pedal crank arm **300** moves downward, the pedal crank arm **210** begins to move upward toward the rotating bar **207** in a direction indicated by reference arrow **802** and the axle **206** and the rotating bar **207** continues rotation in a direction indicated by reference arrow **800**. With reference to FIG. 6G, continued downward force on pedal **203** continues rotation of the axle **206** and the rotating bar **207** in a direction indicated by reference arrow **900**, and with reference to FIG. 6H, continued downward force on pedal **203** continues rotation of the axle **206** and the rotating bar **207** in a direction indicated by reference arrow **3000** until the final phase of the rotation cycle. The final cycle-completion phase is depicted in FIG. 6I. Once the cycle is complete, the pedal crank arm **210** is again positioned such that the pedal **202** is at its zenith the mid crank arm **211** and the crank arm **212** are positioned above the rotating bar **207**, and the top of the cogs **208** and **209** of the rotating bar **207** are in line with the gear system **24** (FIG. 1). Further, the pedal **203** is positioned again at its nadir and the mid crank arm **302** and the crank arm **303** are fully extended.

FIGS. 7 and 8 depict a recumbent bicycle **30** that comprises a crank system **40** in accordance with an embodiment of the present disclosure. In this regard, the crank system **40** is

substantially similar to the crank system **11** depicted in FIG. 1; however, the crank system **40** is mounted to the bicycle **30**, which is a recumbent bicycle. In one embodiment, the recumbent bicycle may further employ a bracket axle location mounted crank substantially similar to crank **21** which is further discussed herein.

FIG. 7 depicts a non-chain-engaging side of the recumbent bicycle **30**. The crank system **40** comprises the rotating bar **207** that rotates when the pedals **202** and **203** are actuated by the bicyclist. The rotation induced in the axle **206** and rotating bar **207** actuates the gear system **24** of the back wheel **2000** causing the recumbent bicycle **30** to travel. FIG. 8 depicts the chain-engaging side of the recumbent bicycle **30**.

FIG. 9 depicts a bicycle **20** equipped with a crank system **21** in accordance with another embodiment of the present disclosure. The bicycle **20** and the crank system **21** are substantially similar to the crank system **11** depicted in FIG. 1. In this regard, the crank system **21** may be operably coupled to other types of vehicles that are fully or partially foot-powered or motor-powered vehicle. For example, the crank system **21** may be used on a recumbent, which is a vehicle in which the cyclist reclines (in a substantially horizontal position) when riding and operating the recumbent.

In this regard, the bicycle **20** comprises the frame **17** coupled to the back wheel **18** and the front wheel **19**. The bicycle frame **17** comprises the top tube **12**, the head tube **15**, the seat tube **13**, the down tube **14**, the seat stay **16**, and the chain stay **20**. Such structural components are linked and integrated as described hereinabove with reference to FIG. 1.

Similar to the crank system **11** (FIG. 1), the crank system **21** translates up and down pedaling motion (as opposed to rotating motion) effectuated by a bicyclist into rotating motion in the wheel **18**. The crank system **21** enables substantially more uniform torque transferred to the wheel **18**.

With reference to FIG. 10, the crank system **21** is substantially similar to the crank system **11**. However, the rotating bar **207** is rotatably coupled to the bracket axle **201** that is rotatably or fixedly coupled within a bore in the bottom bracket shell **200**. In one embodiment the axle **201** can be fixedly coupled to the bottom bracket **200** or to the frame. Further, the crank system **21** comprises a chain **1000** that engages a gear **1001** that is fixedly coupled to the axle **206** and a gear **1002** fixedly coupled to the rotating bar **207** and rotatably coupled to the bracket axle **201**. In this regard, the rotating bar **207** is fixedly coupled to the axle **206** by the rotation of the gear **1001** and gear **1002**, via the chain **1000**. Motion induced in the axle **206**, resulting from the bicyclist's actuation is transferred, via the gear **1001**, the chain **1000** and the lower mounted gear **1002**, to the rotating bar **207**. Such rotation is transferred to the chain **22**. Note that gears **1001** and **1002** have substantially similar radii length.

Further note that in one embodiment, the chain **1000** is a roller chain. However, other types of chains may be used in other embodiments of the present disclosure.

In addition, in one embodiment, the chain **1000** may be replaced with a belt. The belt may be adapted for engagement with a gear/pinion system.

Note that the chain **1000** is a motion transferring device. Further, if a belt is employed in the above-described embodiment, it is also a motion transferring device.

FIG. 11 depicts the non-chain-engaging side view of the crank system **21**. The crank system **21** may be rotated clockwise or counterclockwise by the point indicated by the axle **201** to be mounted at any angle with reference to the ground plane, i.e., the plane parallel to the ground relative to the bicycle **20** (FIG. 9). In this regard, substantially similar to the crank **11**, the rotating bar **207** may be coupled such that the

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top of the cogs **208** and **209** align with the line tangent to the gear **24** (FIG. 9), when the pedal, **202** or **203** have reached the zenith or nadir position.

What is claimed is:

1. A crank system, comprising:

a rotating bar fixedly coupled to a first end of a first axle, the rotating bar adapted for actuating a wheel;

a first crank assembly coupled to the first end of the first axle and coupled to a first pedal;

a second crank assembly coupled to a second end of the first axle and a second pedal,

wherein the first crank assembly and the second crank assembly are coupled to the first axle such that the rotating bar is aligned with a wheel gear assembly adapted for rotating the wheel when the first pedal and second pedal are at their zenith and nadir positions, alternatively,

wherein the first crank assembly comprises a first crank arm fixedly coupled to the first axle, a first mid crank arm, a first pedal crank arm, and the first pedal and the second crank assembly comprises a second crank arm fixedly coupled to the first axle, a second mid crank arm, a second pedal crank arm and the second pedal, and

wherein the first crank arm fixedly coupled to the first axle and the second crank arm fixedly coupled to the first axle are adapted such that during rotation the first crank arm fixedly coupled to the first axle and the second crank arm fixedly coupled to the first axle are positioned longitudinally opposed during a rotational cycle, and the first mid crank arm is rotatably coupled to the first crank arm, and the first pedal crank arm is rotatably coupled to the first mid crank arm and the first pedal.

2. The crank system of claim 1, wherein the second mid crank arm is rotatably coupled to the second crank arm and the second pedal crank arm is rotatably coupled to the second mid crank arm and the second pedal.

3. The crank system of claim 2, wherein the first pedal crank arm is rotatably coupled to a first end of a second axle.

4. The crank system of claim 3, wherein the second pedal crank arm is fixedly coupled to a second end of the second axle.

5. The crank system of claim 2, wherein the second pedal crank arm is rotatably coupled to one end of a second axle.

6. The crank system of claim 5, wherein the first pedal crank arm is fixedly coupled to another end of the second axle.

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7. The crank system of claim 1, wherein the zenith and nadir positions of the first or second pedal are relative to a crank pedal plane.

8. The crank system of claim 1, further comprising at least one additional rotating bar.

9. A crank system, comprising:

a rotating bar fixedly coupled to a first end of a first axle, the rotating bar adapted for actuating a wheel;

a first crank assembly coupled to the first end of the first axle and coupled to a first pedal;

a second crank assembly coupled to a second end of the first axle and a second pedal,

wherein the first crank assembly and the second crank assembly are coupled to the first axle such that the rotating bar is aligned with a wheel gear assembly adapted for rotating the wheel when the first pedal and second pedal are at their zenith and nadir positions, alternatively, wherein the rotating bar comprises at least two slide guides adapted for actuating the wheel, wherein the two slide guides are fixedly and slidably coupled to the rotating bar and adapted and arranged for adjusting a distance of each end from a center point of the rotating bar.

10. The crank system of claim 1, further comprising a motion transferring device coupled to the rotating bar and a wheel gear of the wheel gear assembly for transferring motion from the rotating bar to the wheel, wherein the motion transferring device simultaneously engages two opposing ends of the rotating bar and the wheel gear when the first pedal and second pedal are at their zenith and nadir positions, alternatively.

11. The crank system of claim 10, wherein the rotating bar comprises a first and second cog at opposing ends of the rotating bar for engaging the motion transferring device.

12. The crank system of claim 9, wherein the rotating bar comprises a first set of teeth and a second set of teeth integrally formed on opposing ends of the rotating bar.

13. The crank system of claim 9, wherein the rotating bar is coupled to a second axle and the rotating bar is fixedly coupled to the first axle by a motion transferring device adapted for engaging a first gear coupled to the first axle and a second gear coupled to the rotating bar.

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